Author's response to reviews

Title: An investigation of seasonal variation of child under-nutrition in Malawi: is seasonal food availability an important factor? Findings from a national level cross-sectional study.

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Version: 3 Date: 14 September 2014

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MS #: 1922433666128860  BMC Public Health

Notes on Revision

We appreciate the constructive comments provided by the reviewers, the following notes explain how we have tackled each comment.

Comments from Reviewer 1

1. This paper looks at how season and morbidity are related to child growth in a national sample from a household survey conducted in Malawi. There is an extensive literature on the relationship between morbidity and growth and there is also some literature on the relationship between season and growth, including on relevant paper from Malawi.

The authors should consider these two papers and describe how their present work builds on or adds to the existing literature:


In the present study, the finding of a lag between periods of food insecurity and poor growth was previously documented in the longitudinal study by Maleta and colleagues.

Thank you for providing these two references which we have made reference to. The two articles use longitudinal data and therefore can assess growth velocity whilst our data are cross-sectional. The major strength of our analysis is that we are using nationally-representative data and therefore more likely to have wider, national-level implications than studies on a smaller geographic area. On the issue of a lag effect between nutrient intake and child nutritional status as discussed by Maleta et al. (2003), this is a valid explanation and we have included it in our discussion on page 13. We have also added more references on seasonality and child nutritional status on pages 2 and 3.

2. The authors used IHS data from 2004, but it appears that the most recent IHS in Malawi was conducted in 2010. Can the authors explain why they are using the older data?

The 2010 IHS was not available when this study was undertaken as part of a PhD study in 2009. Since there has been no change to seasons and agricultural patterns in Malawi between 2004 and 2010, we do not think using the recent IHS would give different results in relation to seasonality of child under-nutrition in Malawi.

3. There are 12 tables and figures altogether. This seems excessive. Could some of this information be presented in the text or included as online supplemental material? The tables are numbered starting from Table 5. It seems like Tables 5 and 6 (which are listed as Tables 1 and 2 in the text) could probably be combined. This information should be presented as part of the results rather than in the methods section.
We have reduced the number of tables, and now only have 3 tables and 3 figures.

4. What do the highlighted values in Table 7 represent? Are these significant based on overall chi-squared tests comparing all four periods or are they based on pair-wise comparisons? A footnote with an explanation would be helpful.

We have removed this table. The information that was presented in this table has been presented in the text. We have simplified the weather seasons to only dry and wet.

5. In Table 8, it seems like you should either include “has either a permanent roof or an improved floor” or “has both a permanent roof and an improved floor”. It is difficult to figure out what the interpretation should be when both are in the same model.

We have changed the terminology to make it easier: Poor housing quality (has neither permanent roof nor an improved floor); medium quality (household has only one of the two); and Higher housing quality (has both a permanent roof and an improved floor).

6. Since the authors note a similar pattern in Figures 1 and 2, perhaps one of them could be left out.

Figure 2 has been left out.

7. Figures 3, 4, and 5 could be one figure with 3 panels.

The three figures have been combined, however confidence intervals have been left out. We have explained in the text that the difference in the levels of stunting, underweight and wasting between the period of March to August and September to February was statistically significant for stunting and underweight but not for wasting.

8. Figures 6 and 8 do not seem to be based on IHS data, so it’s not clear why they are included.

We have left the two figures out.

Minor essential revisions:

9. Abstract – Not clear what the last sentence in the Methods sub-section means. In the second half of the sentence, are you saying that you accounted for clustering?

We explored the need for a multilevel model taking into consideration findings from previous studies. Our results showed that both the household level and community (enumeration) level variances were not significant in both the stunting and underweight models after the inclusion of predictor variables. We therefore just considered a single level model. The bit on clustering has therefore been taken out of the abstract.

10. Abstract – Conclusion sub-section – This conclusion could be reserved for the last paragraph of the discussion section. It would be good to conclude the abstract with a sentence related to the title of the paper. Does seasonality matter for growth?

The conclusion of the abstract has been rewritten to reflect the findings of the study.
11. Methods – 3rd paragraph methods - The definition of the lean season (February-September) overlaps with the harvest season (March-August). How is it possible for people to lack food when they are in the harvest period?

This was a mistake which we have corrected. The period is September to February

12. In the second paragraph on page 7, the lean season is defined as September to February, which the opposite of the period mentioned in an earlier paragraph. September to February makes more sense based on the seasons in Malawi.

Corrected as stated above

13. Paragraph on modeling, bottom of page 7/top of page 8, Did you use the chi-squared tested to determine which variables to include in the models? Also, it’s not clear whether the logistic regression and multilevel models are different models.

Yes a chi square test was undertaken to identify significant variables for inclusion in the multivariate analysis. The results of the Chi-square are presented in Table 2, and for the logistic regression in Table 3. We did not use a multilevel model.

14. First 3 sentences of results section (under seasonal food availability) should be moved to methods.

The first sentence has been moved but the other two sentences are relevant to the results section.

15. Results – The text at top of page 10 related to Figure 6 should be removed. This is not based on the data analyzed in this paper.

The figure has been removed and the text has only made reference to the Ministry of Health Nutrition Unit report as a reference

16. Results – The text at the top of page 11 related to Figures 7 and 8 should be removed. Again, this is not based on the data analyzed in this paper.

This has been removed

17. The discussion and conclusions are mainly based on the descriptive data. The models presented in Table 8 show no association of illness with either stunting or underweight, when controlling for other factors. Yet the authors conclude that morbidity is more important than season in determining growth

The model results now show that underweight is significantly associated child illness. Our discussion and conclusion mainly focuses on the finding that there is seasonal variation of child under-nutrition in Malawi and we explain why child morbidity is the likely contributing factor to the seasonal variation in child under-nutrition.

Comments from Reviewer 2

# Major Compulsory Revisions

1. Even though the authors indicated the web site for the survey design it has to be explained in the body of the manuscript to compare the design versus the analysis used. What is the exact design used in this study? Explain
We have explained on pages 4 and 5 the sampling design of the study.

2. How did you ascertain age of the children? Could this have implication on the quality of your anthropometric data? Explain

Data on the age of children aged 6 years or less was provided by the parent or guardian of the child in years and months. This is the standard way of how data on children’s age is obtained in household surveys and we do not think it could have affected the quality of the anthropometric data.

3. The authors were trying to compare nutritional status of under five children across different seasons. How frequent anthropometric measurements have been measured?

This was a cross sectional survey and anthropometric measurements were taken on a single visit. Each district was interviewed every month throughout the year and data for each month is nationally representative. We are therefore able to compare children’s nutritional status at national level across different seasons.

4. What do authors say about using different types of weight measurement scales (Salter versus electronic) on the quality of the data?

We have explained that the difference in the percentage underweight between the IHS 2 and the 2004 MDHS may be as a result of the use different weigh scales, the IHS 2 used salter scales whilst the 2004 MDHS used electronic scales. It is likely that the IHS 2 weight measurements were approximated to the nearest Kg whilst those of DHS 2004 produced exact measurements. This difference however does not have an impact on our study because our interest is to understand seasonal variation of under-nutrition and not estimating the levels of underweight.

5. Was the measurement done for the same child twice during the two major seasons? This determines the design of the study. I am not comfortable with the current analysis approach for this study i.e. binary logistic regression for such data especially if it is a kind of panel data. In such case a conditional fixedeffects or random –effects model based on the Hausman’s test is recommended

As stated above this study was cross sectional and anthropometric measurements were done once per child.

6. Was there any standardization procedure done to maintain quality of anthropometric data at the design stage? If yes, was technical error of measurements (TEM) quantified?

To ensure that similar standards were applied in obtaining anthropometric measurements, the enumerators received training on anthropometric measurements and use of equipment from a UNICEF professional. Since this was a cross sectional study and anthropometric measurements were obtained once per child, there was no need to quantify a technical error of measurements which is necessary in repeated measurements.

7. Which formula and assumptions were used to compute the sample size? Explain, What type of probability sampling procedure was employed? Explain

Please note that we used secondary data and did not design the study design ourselves. Nevertheless, the sample frame included all three regions of Malawi; north, centre and south. The country was stratified into urban and rural strata; A two stage stratified sample was used. In the first stage enumeration areas (the primary sampling units) were selected based on
probability proportional to size based on the enumeration area listing from the 1998 Population and Housing Census. This has been explained on page 4. Anthropometric data was collected from households with children aged less than five years and was available for 6,687 children, which is the sample used in this study.

8. What does multilevel modeling means in this study? Has it been employed? If yes, was it reflected in the tables? Multilevel modeling is quite different from hierarchical approach like conceptual modeling of child malnutrition. If you are referring it, it has to appear in the tabular presentation of the results by taking into account different variables under each causal level.

We explored the need for a multilevel model taking into consideration findings from previous studies. Our results showed that both the household level and community (enumeration) level variances were not significant in both the stunting and underweight models after the inclusion of predictor variables. We therefore just considered a single level model. The bit on clustering has therefore been taken out of the abstract.

9. Did you test explanatory variables for multicollinearity? If yes, how? How about model fit test?

We checked for multicollinearity by running the command `vce,corr` after running the regression in Stata, the results showed that there were no variables whose coefficients were highly correlated. The highest correlation was between the missing category of the variable on improved floor and permanent roof and those with missing information on qualification of the household head which was estimated at -0.47 in the stunting model and -0.49 in the underweight model. We obtained a classification table to check for model fitness, the results showed the percentage correctly specified was higher for stunting model (87.5%) compared in the underweight model (59.5%). The underweight model therefore fitted the data better than the stunting model. We have explained this on page 11.

# Minor Essential Revisions

10. Overall the manuscript requires further language edition throughout.

To the best of our ability, we have edited the manuscript for language.

11. Title: I suggest the title to be rewritten as “seasonal variation of child undernutrition in Malawi: is seasonal food availability an important factor?” and a design of the study to be reflected in the title.

The design has been reflected in the title.

12. Abstract: The objectives of the study indicated in the abstract do not coincide with the text in the manuscript. The method and result sections of the abstract were not well elaborated with key methods and results.

The objectives of the study have been aligned with the text in the manuscript and the methods and results.

13. What is the importance of reporting insignificant finding in abstract section? You better discuss it in the discussion section. In the conclusion section no emphasis was given to key findings and what has been written is simply recommendation. Authors need to conclude based on the key findings of the study.
Further model results indicate that there is a significant relationship between child illness and underweight and that the odds of underweight are also significantly higher for children from households interviewed in the months of March to August compared to those from households interviewed between September to February. This has been reflected in the conclusion.

14. Introduction: The information under this sub-title was well organized. However, the literatures used were almost all not up-to-date. Some citations need to be put at the end of the sentences as highlighted in the document.

_We have provided additional more up to date reference. Citations have been put at the end of sentences._

15. Methods: Some highlighted paragraphs in the method section are not suitable for method section and need to move to the result section.

_These have been moved to the results section_

16. Different seasons of the year have to be explicitly defined without merging them and by notifying the exact timing of data collection.

_The description of seasons is based on what seasons in Malawi are like. Seasons in Malawi are depicted by both the temperature and rainfall. However to simplify the weather seasons we now have grouped the weather seasons into two groups; the wet season and the dry season. The exact timing of data collection is explained in the methods section on page 4 to be from March 2004 to March 2005._

17. Results: This section should begin with socio-demographic characteristics of the study population. Titles of each table and figure should be complete in an attempt to answer questions like “what, where, and when” throughout the document.

_Table 1 showing a summary of various child, household and location characteristics has been provided. All the Tables have a title and it is indicated that the source is IHS 2 within the title._

18. In the multivariable analysis mere description of the results is not enough. Authors need to incorporate measures of association like odds ratio with 95% CI. Reference category was not clearly indicated in the contingency table. The number of the tables is not consistent with what has been mentioned in the Text.

_The description of results gives the odds ratios with a 95% confidence interval and a reference category has been clearly indicated in the Table of results (Table 3). The numbering of Tables is in line with what is stated in the text._

19. Discussion: The discussion is not well balanced and needs to be rewritten. Authors are expected to begin their discussion by presenting the key findings of the study in the first paragraph of the discussion. And then all key findings should be discussed in turn. Results should not be entirely repeated in the discussion.

_The discussion has been redone taking into account the suggestions._

20. The limitations of this study were not well explained by taking into account particularly internal validity of the study.
21. References: Nearly 60% the references used in this manuscript are outdated to compare with the results of this study. Authors are advised to look for more up to date literatures. Authors may make use of the following link if it helps to some extent:
http://www.biomedcentral.com/1471-2458/13/864

Additional recent references have been added and we are grateful for the link provided. Most of the old literature that is in the manuscript relate to seasonal variation in child nutritional status linked to food availability/agricultural activities.

# Discretionary Revisions

22. What did you exclude wasting from the text unlike stunting and under-weight while it has been presented using figure 5?

Wasting was only included in Figure 5 to illustrate that it has a pattern similar to underweight and stunting although it a measure of short term under-nutrition whilst stunting measures chronic under nutrition and underweight is a composite measure of both long term and short term under nutrition. The focus of the paper was on stunting and underweight which affect a bigger number of children in Malawi.

Comments from Reviewer 3

1. I have made several important comments by inserting comments to the .pdf. In short the conceptual frame of different types undernutrition (stunting, underweight and wasting) and their association with their predictors needs revising. Stunting should come well after its cause or after long exposure. Therefore care should be exercised when making predicting association with chronological simultaneous events.

Our analysis uses cross sectional data to investigate if stunting and underweight varies across seasons in Malawi. The explanatory factors used in the study are those identified to have a significant association with stunting and underweight from previous studies as well as conceptual frameworks for child nutritional status as explained on page 6. Considering that other studies have established that stunted children may also have symptoms of short term under nutrition as explained on page 10, it is possible that some of the children identified as stunted are also wasted such that the factors associated with being stunted could be similar to factors associated with being wasted to some extent.

2. By strict definition of sanitation this this by WHO on http://www.who.int/topics/sanitation/en/ it may need you to clarify and provide references for this example. This statement seem to suggest that poor sanitation is a risk of malaria, which may only be true in wider definition.

The sentence has been re-written accordingly by leaving out the words poor sanitation see page 3.

3. This conclusion seem to read out paragraph xx in introduction. if this was known before the study why do the study.
The conclusion has been rewritten

Field preparations start in November and April/May why are care practices looked at from March to August. Is this special type agriculture practices?

The study is not investigating care practices for the period March to August but we are suggesting a possible explanation of the findings of higher stunting during the harvest period (March to August) compared to the lean period (September to February), that the harvest period may take up more of the parents time to the extent that they may forgo some child care commitments i.e. attendance of nutrition rehabilitation clinics. This is only presented as a possible explanation and is based on the anecdotal evidence from Kasungu and findings from previous studies as explained on page 3.

4. These references are based on impact of agriculture on child care in Asia (Bangladesh and Iran) where the type of agriculture is very different. I would think in Malawi time expenditure is rather different based on personal experience and a few people I have asked while trying to vet this opinion. Beside these references are very old considering there is usually influence of innovation in agriculture. It is difficult to think a 30 years old practice in another culture could be a justification in another culture. Could the authors use more relevant and much more recent data.

References that are relevant to African settings (Tanzania, 1992 and Kenya, 1989) and a more recent article from Bolivian Andes, 2012 have been added. There isn’t much literature on time allocation for child care and seasonal agricultural activities in Africa.

5. I would think Malawi peak involvement in Farming actually is January to March.

Generally the farming season starts in November with garden preparation and continues to February when the major farming activities are weeding and fertiliser application. From March it is mainly harvesting that occupies people. The statement: “it is highly likely that mothers reduce child care during the busy harvest time” which was based on anecdotal evidence from Mapemba (2012) that women from Kasungu may choose to forgo taking their undernourished children to nutrition clinics during the tobacco processing times, has been removed and instead a general discussion has been made on how seasonal agricultural activities might affect time allocation for child care on page 3.

6. It would seem the study focused on stunting and underweight which correlate strongly largely due to height. Because of this would one not expect that seasonal effects would be more on wasting than stunting. Stunting being effect of chronic malnutrition (undernutrition) as compared to acute malnutrition (assessed by Weight for Age). My thinking and that of others is that stunting follows wasting if at all but we know that recovery from stunting usually follows weight gain. Stunting may actually be adaptation to chronic moderate undernutrition. Therefore it is possible that the effect of stunting in affluent season is an effect of low nutrition supply in lean month.

Bearing in mind that there could be a lag between a child suffering poor nutrient intake and being affected by poor nutritional status i.e. wasting, underweight or stunting, and
considering that stunting is a result of chronic under-nutrition, we investigated the seasonal distribution of all three forms of under-nutrition. The findings showed that higher rates were observed in the period March to August compared to September to February for all three (stunting, underweight and wasting) as shown in Figure 2. If the level of stunting in the season of plenty was as a result of previous low nutrition supply in lean months, the pattern for wasting and underweight which measure short term nutritional status would have been different (i.e. higher levels in the lean months).

One would indeed expect stunting to correlate more strongly with wasting than underweight since both stunting and wasting use height measurements. We have added a relevant reference on page 10.

7. frequency? d/

(this we suppose is asking how often data was collected throughout the year)
We have mentioned on pages 5 and 6 that data was collected through a single visit and that some households with children aged 6 to 59 months had to be visited twice if children were not available in the first visit. Just to clarify, this data is not longitudinal (not the same children are followed throughout the year). It is a different group of children that are interviewed each month. However each district is interviewed 12 times (one enumeration area or several enumerations areas from each district were interviewed on each of the twelve months of the year).

8. Reference expenditure?

To ensure that data on food expenditure for the two periods (March to August and September to February) was comparable, z scores on food expenditure for the two periods were obtained before merging the data. Standardisation of data through obtaining z scores is a commonly applied statistical procedure.

9. You need to provide more details like name of the instruments, manufacturers, City and country of make for each of the instruments used.

We used secondary data. The IHS is conducted every 5 years by the National Statistical Office. The IHS2 published report did not contain information on names of instruments and the make. Our attempts to obtain this information from the agency in Malawi were not successful.

How about standardization and calibration? Implicitly, you are alleging that one or both data collection methods didn't use the appropriate methods. With such doubt why are you using such data?

We were attempting to explain the differences in the levels of under nutrition between two national surveys conducted during the same period. We have no way of establishing for a fact the "truth". As we have mentioned in the paper, our interest in this paper was not on estimating levels of underweight but on seasonal variation of under-nutrition. The IHS and not DHS have seasonal data.

10. why these cut-offs. Explain more or provide reference supporting the choice mad
This was an initial check of plausibility of data on weights and heights which is incorporated in WHO software to enhance validity at data entry and data import as described on their web page: www.who.int/childgrowth/training. A reference has been provided accordingly.

11. Could be left out as this sound rather obvious. An intelligent reader should deduce this

Has been left out

12. (Page 8) This would benefit from showing the mathematical model or changing the language to express what is the outcome and what is the predictor. Note that the Underweight is considered to depend on both height and wasting.

A mathematical model has been provided on page 7.

Whilst underweight is a composite measure for short term and chronic under-nutrition, the interest of this study is to identify the factors that are significantly associated with being underweight and being stunted i.e. which groups of children are likely to be underweight and which groups are likely to be stunted? We focus on these two measures and not wasting due to their relatively higher prevalence in Malawi.

13. Why not just test for correlation of the these two

We explain why it was important to explore the need for undertaking a multilevel model on page 7 however our exploration revealed that a single level model was adequate for the analysis undertaken and therefore a multilevel model was not pursued.

14. It not clear why its important to report this proportion here. This sentence could benefit from revising elements you want the reader to understand.

The sentence has been revised.

15. maternal education?

The role of maternal education in child nutritional status was not explored in this study since data was collected from household heads and the majority are male, i.e only 17% of the households were headed by females. Instead we used the variable on qualification of the household head.

16. To analyse food availability across the year, an exploration of annual household food expenditure across the year is done. Duplicates a sentence in methods

We have checked for duplication and made the required correction

17. Definitions should be taken elsewhere or avoided considering the target audience are peers who should know the definition or can find the definitions themselves.

The definition has been provided as a footnote
18. Why providing both Figure 1 and 2 if the information is the same?

*Figure 2 has been removed*

19. Why is March lean period yet household food expenditure in is already high in that month as shown in figures 1 and 2

*This has been corrected to show that March is in the harvest period*

20. Typically the national program (CMAM) uses Severe Acute Malnutrition and Moderate Acute Malnutrition. It would be better to use the same if thats what the authors are referring to here.

*The sentence has been changed such that it merely refers to under-nourished children requiring admission since the information provided did not make any reference to the CMAM programme*

21. Ministry of Agriculture does not treat malnourished children and do not collect such data. Data from nutrition treatment is collected through CMAM programme in the Ministry of Health. I could prefer quoting the programme data.

*The source has been verified to be Ministry of Health Nutrition Unit and has been corrected accordingly*

22. Probably true but the authors may need to demonstrate with more evidence. Authors should realise that admission criteria for OTP is wasting while their case here is that of stunting and underweight.

The authors needs to ensure that the argument here is takes into account the fact that NRU admissions are lowest as compared to the other two components of CMAM (OTP and SFP)

*Whilst our case is stunting and underweight and the admission criteria for OTP (Outpatient Therapeutic Programme) is wasting, our results show that across the year, the distribution of stunting is similar to the distribution of wasting and evidence suggests that wasting and stunting indicators are closely associated, such that children that are wasted may also be stunted or underweight. This we have explained on page 10. The OTP is undertaken in specially designated clinics and therefore mothers and children attending such clinics are likely to miss household interviews. We have also mentioned that the SFP (Supplementary Feeding Programme) could also be supporting the nutrition needs of children and contributing to the lower levels of under-nutrition in the lean months.*

23. This impression need re-examination. Malaria seem to peak from as early as January. Also note that acute illnesses may actually affect wasting more quickly than stunting. And most likely if they affect stunting it should lag behind the morbidity.

*The Figure being referred to has been removed. Whilst acute illness might affect wasting more quickly than stunting, as mentioned under point 20, wasting and stunting are closely associated and our results show that the distribution of the two indicators show a similar distribution across the year.*

24. Discussion should be redone after taking into account of above comments
This has been redone

25. Conclusion should be redone. See my previous comments.
   This has been redone